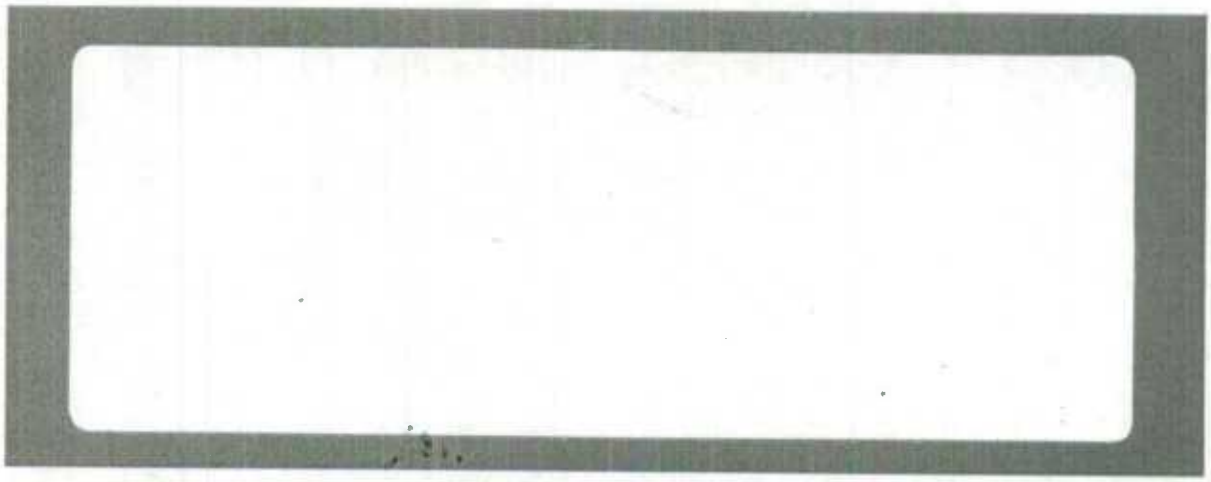
Statistics Canada Statistique Canada



Methodology Branch

Household Survey Methods Division

Direction de la méthodologie

Division des méthodes d'enquêtes des ménages

Canada

METHODOLOGY BRANCH
WORKING PAPER SERIES

# CHOICES OF ALPHA VALUE IN REGRESSION COMPOSITE ESTIMATION FOR THE CANADIAN LABOUR FORCE SURVEY: IMPACTS AND EVALUATION

HSMD-2002-005E

Edward J. Chen and T.P. Liu



Labour Force Survey Methods Section
Household Survey Methods Division
Statistics Canada

November, 2002

# Choices of Alpha Value in Regression Composite Estimation for the Canadian Labour Force Survey: Impacts and Evaluation

Edward J. Chen and T.P. Liu1

ABSTRACT

The Canadian Labour Force Survey (LFS) is a continuous monthly survey with a complex rotating panel design where there is a 5/6 sample overlap between any two consecutive months. After extensive studies, including the investigation of a number of alternative methods for exploiting the sample overlap to improve the quality of estimates, the LFS has chosen and implemented a regression composite estimation method. Currently, a compromise linear estimator between level and monthly change driven estimates with the $\alpha$ value of 2/3 is implemented. This study is to evaluate a broad range of $\alpha$ values on many different LFS characteristics and its impacts on the final survey weights.

KEY WORDS: Variance estimation system; Survey Weights; Level estimate; Change estimate.

1 Edward J. Chen and T.P. Liu, Labour Force Survey Methods section, Household Survey Methods Division, Methodology Branch, Statistics Canada, Ottawa, Ontario, K1A 0T6

# Évaluation de l'impact du choix du paramètre Alpha pour l'estimateur composite par régression de l'Enquête canadienne sur la population active

**Edward J. Chen and T.P. Liu2**

RÉSUMÉ

L'Enquête sur la population active du Canada (EPA) est une enquête mensuelle possédant un plan d'échantillonnage complexe avec rotation, de façon à ce qu'il y ait toujours 5/6 de l'échantillon qui se chevauche d'un mois à l'autre. Après avoir effectué plusieurs études approfondies d'évaluation des méthodes d'estimations, incluant un certain nombre de méthodes exploitant le chevauchement de l'échantillon, l'EPA a décidé d'implanter une méthode d'estimation composite par régression. Présentement, un estimateur linéaire faisant le compromis entre le niveau et le changement mensuel a été implanté, avec un paramètre $\alpha$ de 2/3. Le but de la présente étude est de regarder un grand nombre de possibilités pour $\alpha$ et d'évaluer l'impact sur plusieurs caractéristiques de l'EPA, ainsi que sur les poids de sondage finaux.

MOTS CLÉS: Système d'estimation de la variance; poids de sondage; estimation de niveau; estimation de changement.

2 Edward J. Chen et T.P. Liu, Section des méthods de l'Enquête sur la population active, Division des méthods d'enquêtes auprès des ménages, Statistique Canada, Ottawa, Ontario, K1A 0T6

## 1. INTRODUCTION

The Canadian Labour Force Survey (LFS) is a monthly survey of approximately 54,000 households selected using a stratified multistage design. Households stay in the sample for six consecutive months, thus five-sixths of the sample is common between two consecutive months. Each month, the members of a selected household are asked questions about their labour force status, earnings, and so on. In the LFS estimation system used prior to 2000, initial design weights were modified using regression to produce final weights that respect age-sex and geographical (subprovincial region) *population control totals*. Each record then had a *unique final weight* that is used for all tabulations.

Since January 2000, the LFS has successfully implemented a new estimator known as the regression composite estimator - see Gambino, Kennedy and Singh (2001) for a detailed discussion from which most of the introduction of this paper has heavily borrowed. The implementation of the new composite estimator is judged not only on its statistical efficiency but also its stability over time and its cost effectiveness, while achieving the following objectives: (i) minimizing changes to the old estimation system, (ii) producing a unique weight for each sample unit (iii) respecting age-sex and geography control totals and (iv) producing consistent estimates (in the sense that, *e.g.*, Employed + Unemployed = Labour Force and Labour Force + Not In Labour Force = Population 15+).

The estimation system prior to composite estimation used data from the current month only (henceforth referred to as GREG). No attempt was made to exploit the fact that the common sample can be used to improve estimates. However, characteristics such as employment (especially employment by industry) are highly correlated over time and unemployment is moderately correlated over time, thus there is potential for efficiency gains. Because of these gains, surveys similar to the LFS, such as the United States Current Population Survey (CPS), have used composite estimation to improve their estimates for many years.

Traditionally, the key estimates produced by the LFS were monthly unemployment rates. However, with the increasing emphasis on estimates of employment level and on estimates of change in recent years, the need to find ways to make use of the common sample also increased since these estimates would benefit significantly. In the mid-1990s, therefore, interest in composite estimation was revived at Statistics Canada, and a regression-based method that fit in well with the existing LFS estimation system was developed. This method is first described in Singh, Kennedy, Wu and Brisebois (1997) with a more up to date version included in Singh *et al.* (2001). The new methodology allows for a

choice of methods, depending on one's objectives. If the primary interest is in estimates of level, then one can use level-driven predictors in the procedure. If change is most important, then change-driven predictors can be used. One can go one step further and include both types of predictor in the procedure.

The method used since January 2000 addressed the problems with traditional composite estimators and showed substantial gains in efficiency. Also both estimates of level and of change were given importance in the choice of predictors. A method suggested by Fuller, that combines the change-driven and level-driven approaches without the constraints associated with including both sets of predictors in the regression was adopted (see Fuller and Rao, 2001). The solution is remarkably straightforward: take a linear combination of the level and change predictors: $X = (1-\alpha)X_L + \alpha X_C$, and use it as the predictor. The level- and change-driven predictors are now special cases, corresponding to $\alpha = 0$ and $\alpha = 1$ respectively. Furthermore, one can choose $\alpha$ to reflect the relative importance one wishes to give to level versus change, i.e., the higher $\alpha$ value would give more importance to change versus level estimates. A compromise choice of $\alpha = 0.67$ is implemented in the current LFS estimation system.

The introduction of the composite estimates also added more control totals to the weighting system. As a result, more extreme final weights could be produced. Moreover, the choice of $\alpha$ value could be related to distortion of the final sample weights.

This paper describes an extensive evaluation of the composite estimator using actual LFS data for a large number of characteristics over a long period of time from July 2000 to June 2001 with February 1998 as the first starting month of composite (i.e., February 1998 to June 2000 is the break-in period). The objectives of the study and methods used to evaluate a broad range of $\alpha$ values ($\alpha$ = 0.20, 0.40, 0.50, 0.60, 0.67 and 0.80) are described in Section 2. The results of the study on the impacts of final weights, the examination of break-in period and the relative efficiency for different $\alpha$ values for both the level and change estimates are summarised in Section 3. The concluding remarks are in Section 4.

## 2. ALPHA VALUES AND STUDY OBJECTIVES

**Choices of α value**: In this study, a wide range of α values is used to evaluate the relative efficiency and the impacts on the final weights. The choices of α value under study are α = 0.20, 0.40, 0.50, 0.60, and 0.80 in addition to the current α value = 0.67. Two additional α values, α = 0.70 and α = 0.75 were also computed to examine the sensitivity of the choice of α value but they are not reported here since most of the results fall in between those of α = 0.67 and α = 0.80. The relative efficiency that evaluates the performance of the variance of the composite estimator compared to the generalised regression estimator (GREG) used prior to the introduction of the composite estimator is defined as

$$RE = Var(GREG)*100/Var(composite).$$

This relative efficiency is computed for each of the α values and the characteristics. A value of RE greater than 100 would indicate composite is a more efficient estimator than the GREG estimator is whereas a value less than 100 would indicate less efficient compared to the GREG estimator.

**Extreme weights**: With the introduction of the composite estimator, 28 more independent variables (see Appendix for the list) for each province have been added in the regression as control totals that may further distort the final weights in the estimation system. The distortion usually results in more extreme weights such as more negative weights or more large weights produced. The distortion could be related to the α values.

**Break-in period**: The relative efficiency gains are related to the number of months of 'compositing' in order for the composite estimator to fully realize its gains. The number of months of 'compositing' required highly depends on the characteristic and its variability and correlation over time. The relative efficiency reported should be after a period when the efficiency gains of the estimates are stabilised, i.e., after the break-in period.

**Study objectives**: The objectives of this study are to investigate:

1. Whether the current α = 0.67 produces 'optimal' (or close to optimal) estimates of both level and change, i.e., whether it is a good compromise choice;
2. Whether a different α value should be used for different characteristics or province;
3. The break-in period, i.e., how many months it takes for the benefit of "compositing" to be fully realized?
4. Impacts of different α values on the final weights and their distribution vs. the GREG

estimator.

Since the value $\alpha = 0.67$ is used for all types of estimates in all provinces in the current estimation system, the characteristics in this study include all the estimates published in the LFS monthly press releases, namely, the variables in Labour Force, Employment, Unemployment and Unemployment rate by major age groups 15-24 years, 25 years and over by sex in all provinces and the Canada total. The employment variables by class of worker (employee and self-employed), by type of industry, by sector (public and private) and by employment status (full-time and part-time) are also included in the study.

In this study, 12 months of LFS data from July, 2000 to June, 2001 are used to compute and compare the relative efficiencies, with the first month composite estimates starting from February, 1998. We also compared the results from the first month composite estimates starting from March, 1995 (the LFS production version) and found no major differences with the results from the first month composite estimates starting from February, 1998.

## 3. RESULTS

We present a detailed summary of results for the 6 different choices of $\alpha$ value in the regression composite estimator. Two additional $\alpha$ values $\alpha = 0.70$ and $\alpha = 0.75$ are also computed to examine the sensitivity of the choice of $\alpha$ values but they are not reported here since most of the results fall in between the $\alpha = 0.67$ and $\alpha = 0.80$ ones. Only some numerical results are presented in the section below.

**3.1 Impacts on final weights**. As discussed in Gambino, Kennedy and Singh (2001), unlike the traditional A-K composite estimator, where weighting to satisfy population control totals and composite estimation are separate steps, weighting for the regression composite estimator is done in one step, *i.e.*, simultaneously with weighting to satisfy the age-sex and geographical controls. This procedure not only preserves the consistency but also retains the benefits of the controls applied to the usual regression estimator, i.e., the age-sex and geographic controls in our case.

These benefits also could have their drawbacks. There could be more extreme final weights produced by the new estimation system in order to satisfy the increased number of control totals. See Appendix for a complete list of demographic control totals and composite controls in the new estimation system. The composite controls have been added to the old system since January 2000 (with rebasing estimates back to January 1996). Moreover, the presence of extreme final weights

could be directly related to the choice of α values.

Table 1 below presents the examination of the final weights by the GREG estimator and the 6 different α values over the 12-month period in Canada. There are a few more extreme weights with the composite estimator. The presence of the extreme weights (by the measures of minimum value, maximum value and minimum and maximum number of negative weights per month) is directly related to the α values. It seems the higher the α value, the more extreme negative weights it produces and the more negative weights per month there are. Therefore, the average number of negative weights per month tends to increase with the α value.1

TABLE 1. Final Weights Distribution: GREG vs. by Alpha Values July, 2000 to June, 2001

| **Final Weights** | **GREG** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| Minimum Weight | -132 | -130 | -133 | -135 | -138 | -200 | -302 |
| Maximum Weight | 2008 | 2068 | 2017 | 1987 | 1954 | 1981 | 2054 |
| Min. No. Neg. Weight/Month | 0 | 0 | 2 | 2 | 4 | 4 | 8 |
| Max. No. Neg. Weight/Month | 4 | 12 | 12 | 13 | 16 | 20 | 25 |
| Ave. No. Neg. Weight/Month | 1.3 | 4.2 | 5.1 | 6.1 | 8.2 | 8.8 | 13.3 |
| 1st Percentile | 31 | 30 | 30 | 30 | 30 | 30 | 30 |
| Median Weight | 165.0 | 164.5 | 164.5 | 164.5 | 164.5 | 164.5 | 164.0 |
| Average Weight | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 |
| 99th Percentile | 913 | 914 | 915 | 917 | 920 | 922 | 923 |

1 These final weights are obtained directly from the variance estimation system, which differs from the production system where the negative weights are replaced by the initial weights and the weighting step is repeated. If there are still negative weights after this step, the negative weights are then replaced by the value 1.

The distribution analysis is also performed over the 12-month period to examine the first percentile, median, average and the 99$^{th}$ percentile of the final weights. The measures do not differ between the GREG and composite estimator nor vary greatly by the $\alpha$ values, as expected.

The negative final weights tend to concentrate in the province of Alberta which accounts for almost 50% of all negative weights. Efforts are under way to examine further this phenomenon.

**3.2 Break-in period.** It is recognized that it takes several months of 'compositing' for the regression composite estimator to fully realize the efficiency gains. The number of months of compositing required highly depends on the variability of the characteristic and correlation over time. In this study, we examine this break-in period for the variables Employment, Unemployment and Employment by Industry in 6 key industries, i.e., the largest 3 and smallest 3 employment industries in Canada. The largest 3 employment industries in order are Employment in Trade, Health Services and Manufacturing. The smallest 3 are Employment in Agriculture, Natural Resources and Utilities.

The examinations are performed by plotting the GREG variance estimates and variance estimates of the composite estimator (with $\alpha = 0.67$) from February, 1998 (when the first month of composite starts) to June, 2001. The reduction of the composite variance of employment in Canada starts to stabilize after 6 months of compositing (See Fig. 1). The 3 major industries show almost immediate gains and start to show stability after about 8 months of compositing. (See Fig. 2, Fig. 3 and Fig. 4). However, it would take about 18 months of compositing for Employment in Agriculture and about 25 months for Employment in Natural Resources to fully realize their gains, mainly due to their variability and correlation over time. Not surprisingly, the GREG variance estimates of the smallest 2 industries i.e., Employment in Natural Resources (See Fig. 5) and in Utilities (See Fig. 6) are very sporadic whereas the composite estimates are much more stable over time. It further demonstrates the stability of the composite estimates vs. the GREG estimates as discussed in Gambino, Kennedy and Singh (2001).

We decided to use after the 30 months of compositing to compute the RE from the examination. 30 months of compositing is a more reasonable choice for the wide range of characteristics and province estimates under study.

FIGURE 1. Comparison of Variance Estimates - Composites vs. GREG
Employment and Unemployment

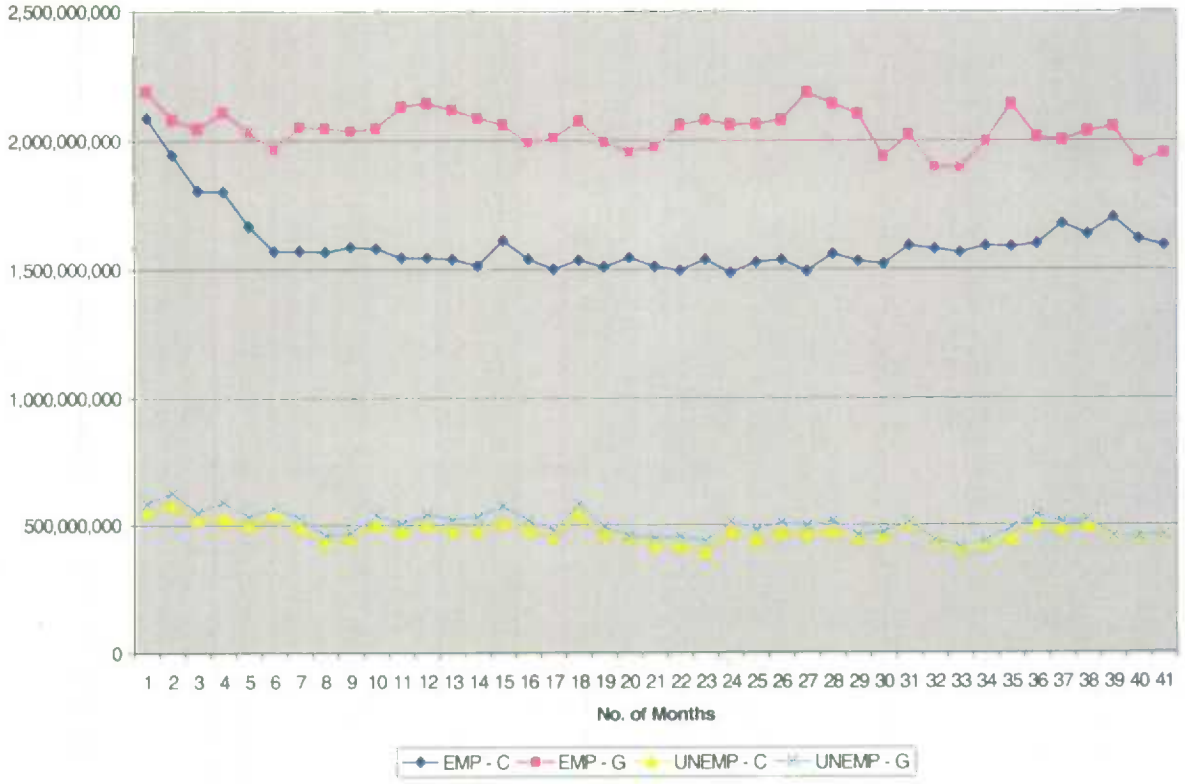



FIGURE 2. Comparison of Variance Estimates - Composites vs. GREG
Employment in Trade and Health Service

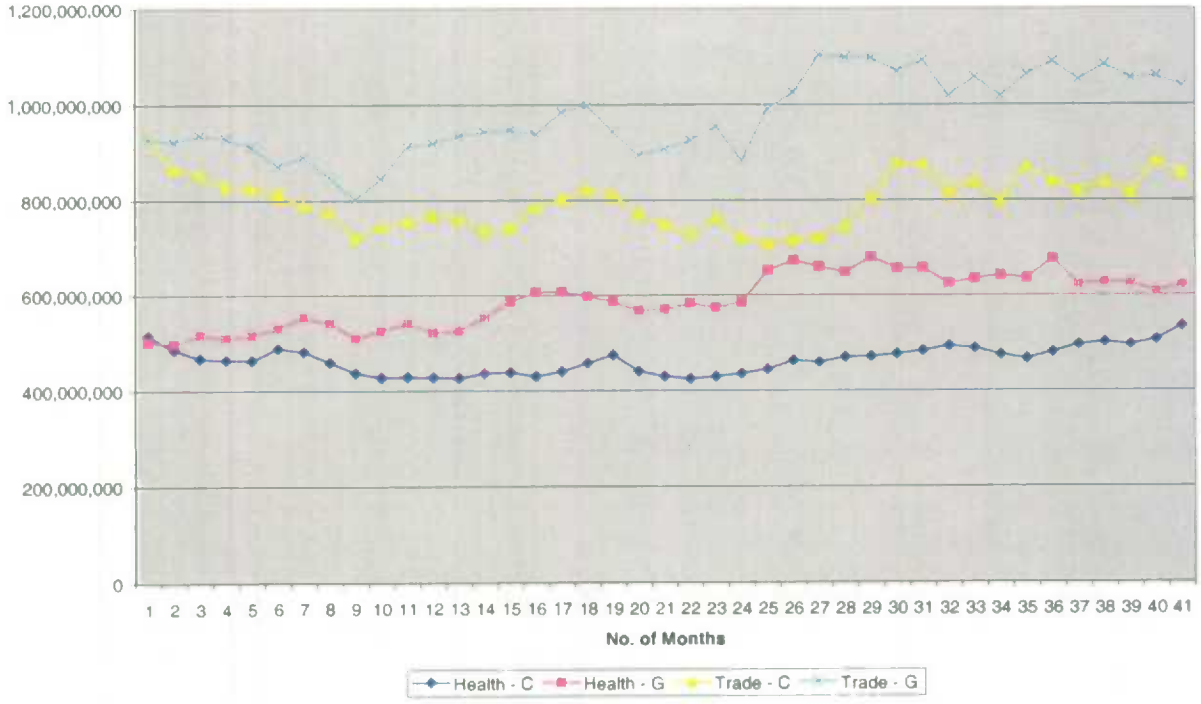


FIGURE 3. Comparison of Variance Estimates - Composites vs. GREG
Employment in Manufacturing

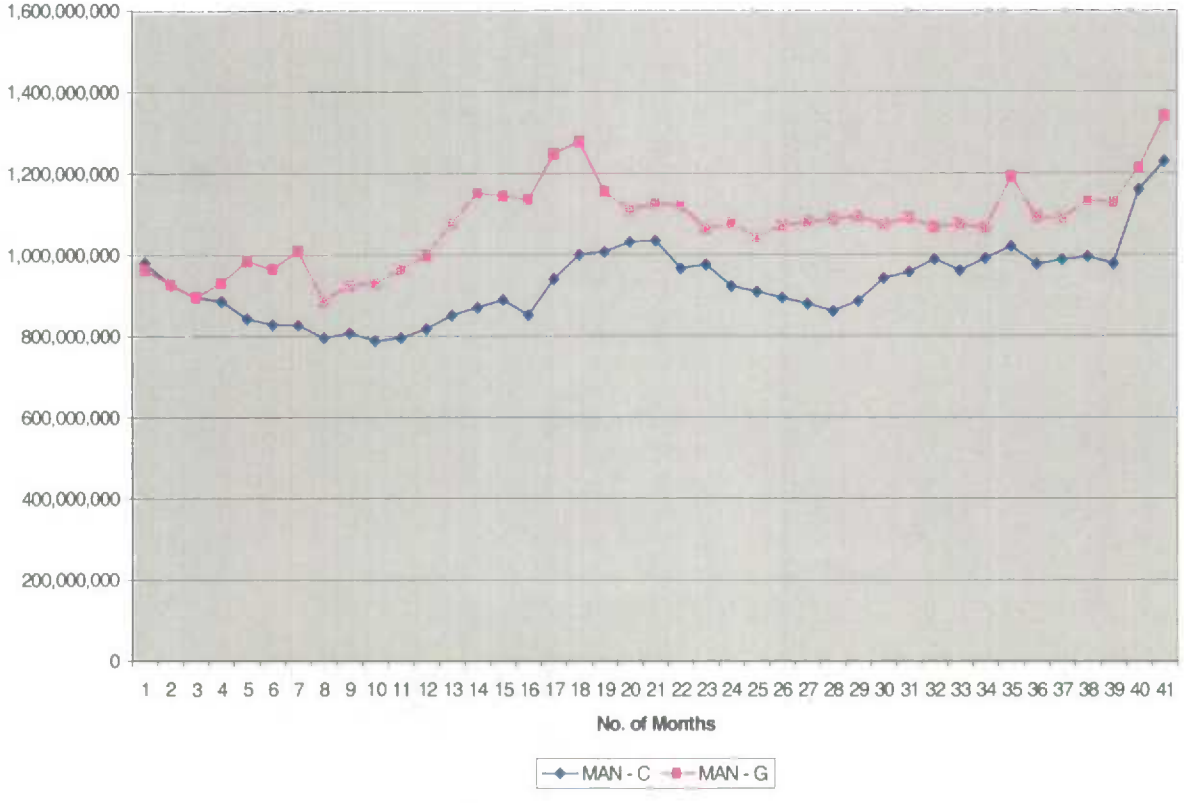



FIGURE 4. Comparison of Variance Estimates - Composites vs. GREG
Employed in Agriculture

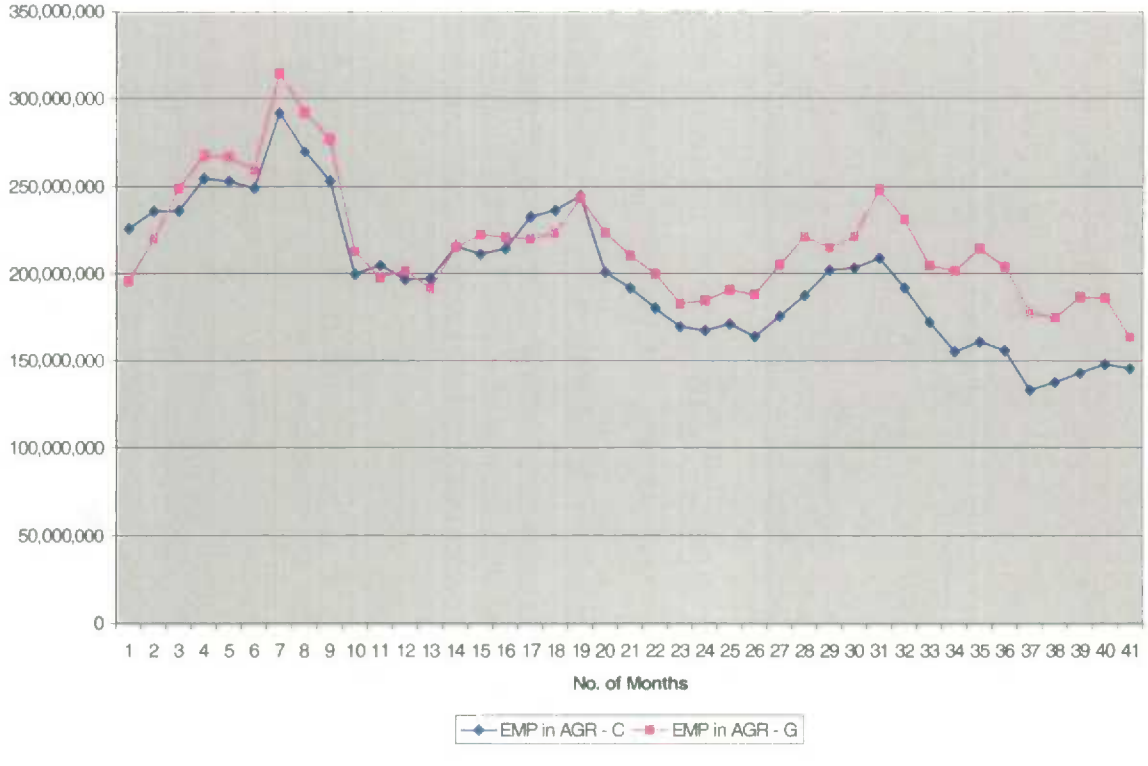


FIGURE 5. Comparison of Variance Estimates - Composites vs. GREG
Employment in Natural Resources

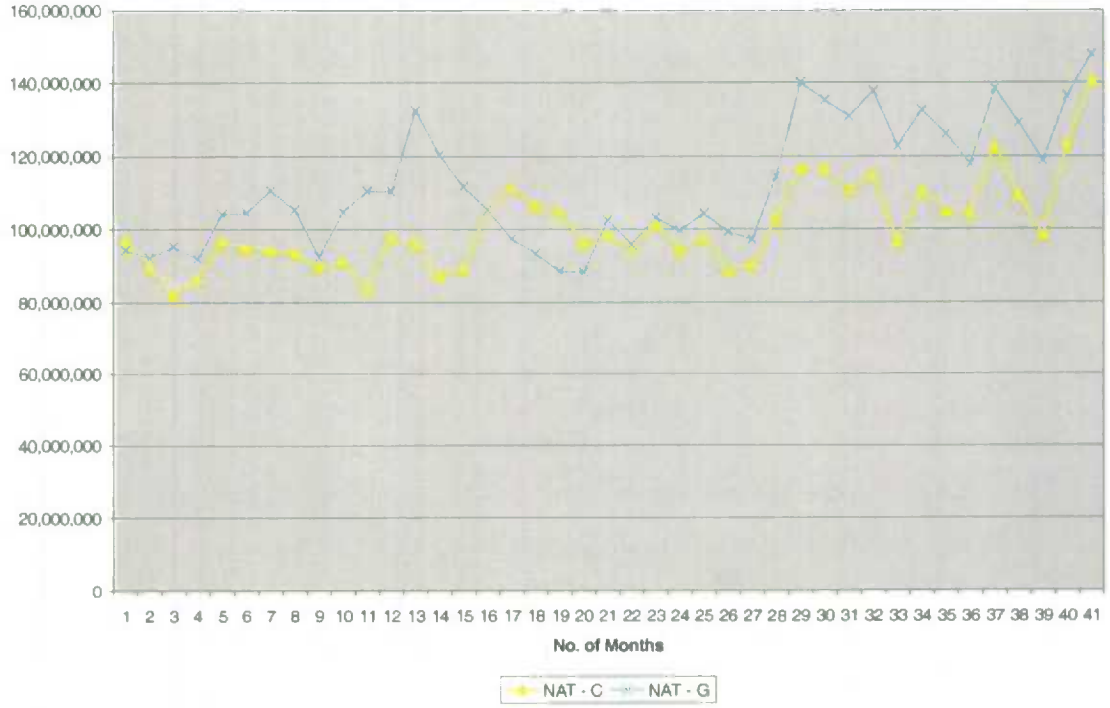
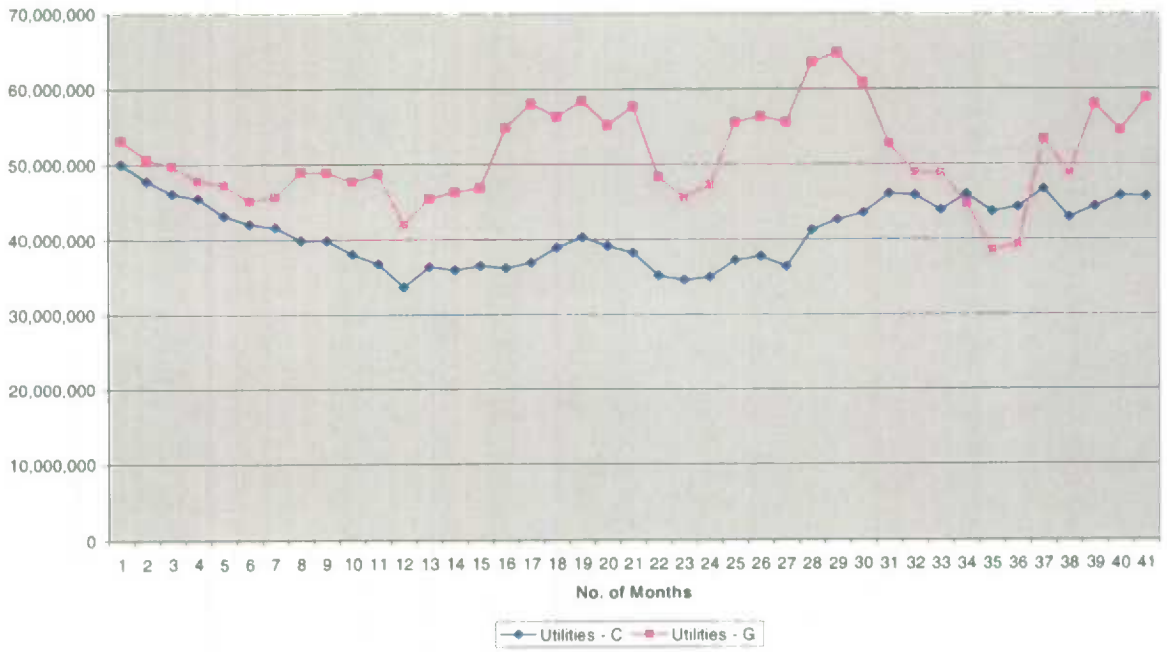



FIGURE 6. Comparison of Variance Estimates - Composites vs. GREG
Employment in Utilities



**3.3 Efficiency gains**. For the variables that are added as control totals, there are substantial gains in efficiency for both estimates of level and change. For $\alpha = 1$, the gains for estimates of change are 'optimal'; by choosing a smaller value of $\alpha$ we gain more for estimates of level while reducing the magnitude of the gains for estimates of change.

We present the evaluation results separately for the Level estimates and Monthly Change estimates.

## LEVEL ESTIMATES:

### 4.2.1 Labour force status variables (in labour force, employment, unemployment and unemployment rates by sex, major age groups, and province and Canada total)

The current $\alpha = 0.67$ produces very efficient level estimates as compared with other choices of $\alpha$ value. While the current $\alpha = 0.67$ does not produce any significantly better gains over other choices of $\alpha$ value (most of the differences in gains are in the 1% range), it does not produce the least efficient estimates either except for the unemployment related variables where the difference of gains are within 2% at Canada level (See Table 2 below). The bold face relative efficiency indicates the highest gains and the italics indicate the least gains among different choices of $\alpha$ value. The results of Employment and Unemployment by sex and major age groups are found in Appendix.

TABLE 2. Relative Efficiency by Labour Force Status, Canada by Alpha Values

Level Estimates

| Labour Force Status | Sexes | 0.20 | 0.40 | 0.50 | 0.60 | 0.67 | 0.80 |
|---|---|---|---|---|---|---|---|
| Employment | Both Sexes | *112.6* | 119.7 | 122.3 | 123.7 | **123.9** | 122.7 |
| | Males | *111.5* | 116.0 | 117.3 | **117.7** | 117.5 | 116.1 |
| | Females | *119.8* | 127.1 | 129.6 | 130.8 | **130.9** | 129.5 |
| In Labour Force | Both Sexes | *110.0* | 117.1 | 119.8 | 121.4 | **121.7** | 120.8 |
| | Males | *108.5* | 113.2 | 114.7 | 115.5 | **115.5** | 114.6 |
| | Females | *116.9* | 123.7 | 126.1 | 127.4 | **127.6** | 126.4 |
| Unemployment | Both Sexes | **105.4** | 105.2 | 104.8 | 104.2 | 103.8 | *102.8* |
| | Males | **104.7** | 104.3 | 103.8 | 103.1 | 102.6 | *101.5* |
| | Females | **105.9** | 105.7 | 105.4 | 104.8 | 104.4 | *103.4* |
| Unemployment Rate | Both Sexes | 106.3 | **106.3** | 105.9 | 105.2 | 104.7 | *103.3* |
| | Males | **104.9** | 104.4 | 103.8 | 103.1 | 102.5 | *101.2* |
| | Females | 107.9 | **107.9** | 107.5 | 106.9 | 106.3 | *104.9* |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

Similar results can be seen at the provincial level for the Employment, in Labour Force (results not shown) and unemployment related variables. The best α value for Employment tends to be at α = 0.67 at the province level whereas for Unemployment related variables it tends to be 0.20, especially for Nova Scotia and New Brunswick where the gains could be up to 5% higher than the current α = 0.67 (See Table 3). The optimal α value for Unemployment or related variables may be at a value lower than α = 0.20 but it was not under our investigation.

Note: The current α = 0.67 can also produce less efficient estimates (than the GREG estimator) in several provinces (not at Canada level) especially for the Unemployment related variables by sex and age groups, where the efficiency can be less by up to 5%. The less efficient estimates can happen for any choice of α values that the α = 0.20 would have the least happening.

TABLE 3. Relative Efficiency by Labour Force Status and Province by Alpha Values

Level Estimates

| Labour Force Status | Province | 0.20 | 0.40 | 0.50 | 0.60 | 0.67 | 0.80 |
|---|---|---|---|---|---|---|---|
| Employment | Newfoundland | *110.9* | 118.5 | 121.3 | 122.9 | **123.3** | 122.4 |
| | Prince Edward Island | *112.2* | 118.1 | 119.7 | **120.2** | 120.0 | 118.6 |
| | Nova Scotia | *112.6* | 120.1 | 122.8 | **124.0** | 123.9 | 121.4 |
| | New Brunswick | *113.3* | 120.2 | 122.7 | 123.9 | **124.0** | 122.7 |
| | Québec | *110.1* | 117.0 | 119.7 | 121.3 | **121.8** | 121.2 |
| | Ontario | *114.4* | 122.1 | 124.8 | **126.1** | 126.1 | 124.1 |
| | Manitoba | *116.2* | 124.9 | 128.2 | 130.0 | **130.3** | 128.9 |
| | Saskatchewan | *110.5* | 117.3 | 119.9 | 121.5 | **122.1** | 121.9 |
| | Alberta | *113.0* | 118.7 | 120.7 | 121.8 | **122.0** | 121.1 |
| | British Columbia | *113.5* | 120.3 | 122.8 | 124.2 | **124.5** | 123.5 |
| Unemployment | Newfoundland | **106.7** | 106.4 | 106.0 | 105.5 | 105.0 | *104.1* |
| | Prince Edward Island | *112.6* | 115.5 | 116.2 | **116.4** | 116.3 | 115.4 |
| | Nova Scotia | **106.3** | 105.4 | 104.7 | 103.8 | 103.2 | *101.8* |
| | New Brunswick | **102.6** | 100.4 | 99.2 | 97.9 | 97.1 | *95.3* |
| | Québec | 105.9 | **106.1** | 105.8 | 105.4 | 105.0 | *104.1* |
| | Ontario | **104.9** | 104.6 | 104.2 | 103.5 | 103.1 | *102.0* |
| | Manitoba | 105.1 | 106.1 | **106.2** | 106.0 | 105.7 | *104.9* |
| | Saskatchewan | 100.4 | 101.9 | 102.4 | 102.8 | 103.0 | **103.2** |
| | Alberta | **104.4** | 104.1 | 103.8 | 103.3 | 102.9 | *101.9* |
| | British Columbia | **106.2** | 105.7 | 105.1 | 104.4 | 103.8 | *102.6* |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

### 4.2.2 Employment by Class of Worker, Sector, Industry and Status, Canada

The current $\alpha = 0.67$ produces very efficient estimates as compared with other choices of $\alpha$ value. While the current $\alpha = 0.67$ does not produce any significantly better gains over other choices of $\alpha$ value (most of the differences of gains are in the 3% range), it does not produce the least efficient estimates either at Canada level (See Table 4 below). The best $\alpha$ value for Employment by Class of Worker, by Sector, by Industry, and by Employment Status variables tend to be around 0.40 to 0.50 at the Canada level.

TABLE 4. RE of Employment by Class of Worker, Sector and Industry, Canada by Alpha Values

| Level Estimates<br>**Employment** | 0.20 | 0.40 | 0.50 | 0.60 | 0.67 | 0.80 |
|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | |
| Employees | *112.3* | 115.8 | **116.3** | 115.9 | 115.3 | 113.3 |
| Self Employed | 118.5 | 121.8 | **122.0** | 121.2 | 120.2 | *117.6* |
| **By Sector** | | | | | | |
| Public Sector | *118.1* | 121.9 | **122.4** | 121.8 | 121.0 | 118.7 |
| Private Sector | *115.2* | 120.2 | 121.5 | **121.7** | 121.3 | 119.4 |
| **Goods-Producing** | 114.1 | **116.2** | 115.9 | 114.7 | 113.6 | *110.8* |
| Agriculture | *110.2* | 117.9 | 121.0 | 123.3 | 124.3 | **125.2** |
| Construction | 118.4 | **119.7** | 119.1 | 117.9 | 116.8 | *114.2* |
| Manufacturing | 114.5 | **115.4** | 114.5 | 112.8 | 111.3 | *108.3* |
| Natural Resources | 116.6 | **118.7** | 118.6 | 117.7 | 116.8 | *114.4* |
| Utilities | **120.1** | 119.6 | 117.6 | 114.8 | 112.6 | *108.2* |
| **Services-Producing** | *114.1* | 119.3 | 120.6 | **120.9** | 120.6 | 118.9 |
| Accomodation and Food Services | 115.0 | **115.9** | 115.3 | 114.0 | 112.9 | *110.5* |
| Educational Services | 121.5 | **124.3** | 124.0 | 122.7 | 121.4 | *118.3* |
| Finance, Insurance and Real Estate | *122.0* | 126.2 | **126.7** | 126.2 | 125.4 | 123.2 |
| Health Care and Social Assistance | *126.2* | 130.7 | **131.3** | 130.7 | 129.7 | 127.0 |
| Information, Culture and Recreation | 117.0 | **118.6** | 118.0 | 116.5 | 115.3 | *112.5* |
| Management, Administative and Other Support | 116.8 | **117.8** | 117.2 | 116.1 | 115.0 | *112.6* |
| Other Services | 119.6 | **120.9** | 120.1 | 118.6 | 117.3 | *114.5* |
| Professional, Scientifice and Technical Services | 119.0 | 122.3 | **122.4** | 121.7 | 120.7 | *118.3* |
| Public Administration | 120.1 | 124.0 | **124.1** | 123.1 | 122.0 | *119.1* |
| Trade | 124.8 | **127.9** | 127.7 | 126.6 | 125.3 | *122.2* |
| Transportation and Warehousing | 116.9 | **119.1** | 118.9 | 117.9 | 116.8 | *114.0* |
| Full Time Employment | *106.1* | 110.1 | 111.5 | 112.4 | **112.5** | 112.0 |
| Part Time Employment | *102.3* | 102.9 | 103.1 | 103.3 | **103.3** | 103.2 |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

### 4.2.3 Employment by Class of Worker, Sector, Industry and Status, Provinces

Since there are 10 different sets of results for the 10 provinces' Employment by Class of Worker, Sector, and Industry variables, we present here only the highest relative efficiency gains (see Table

TABLE 5. Highest Relative Efficiency Gains Among Provinces of Employment by Class of Worker, Sector and Industry by Alpha Values

| Level Estimates<br>**Employment** | **Province** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | | |
| Employees | Manitoba | *124.2* | 130.9 | 132.7 | **133.1** | 132.6 | 130.4 |
| Self Employed | Manitoba | *131.9* | 143.2 | 146.5 | **147.6** | 147.2 | 144.2 |
| **By Sector** | | | | | | | |
| Public Sector | Saskatchewan | *127.3* | 134.5 | 136.5 | **137.0** | 136.6 | 134.7 |
| Private Sector | Saskatchewan | *121.8* | 132.2 | 136.2 | 138.8 | **139.7** | 139.5 |
| **Goods-Producing** | Manitoba | *119.5* | 128.8 | 132.1 | 134.1 | **134.7** | 134.2 |
| Agriculture | Québec | *125.5* | 135.9 | 140.3 | 143.5 | 144.9 | **146.2** |
| Construction | Manitoba | 132.9 | **134.7** | 133.6 | 131.3 | 129.2 | *124.0* |
| Manufacturing | Manitoba | *133.3* | 141.6 | 144.2 | 145.5 | **145.8** | 145.1 |
| Natural Resources | Saskatchewan | *123.2* | 134.3 | 138.9 | 142.4 | 144.2 | **146.0** |
| Utilities | Newfoundland | *197.4* | 228.3 | 236.2 | **238.1** | 236.7 | 231.2 |
| **Services-Producing** | Saskatchewan | *114.8* | 122.8 | 125.7 | 127.4 | **127.9** | 127.5 |
| Accomodation and Food Services | Québec | *117.9* | 121.3 | **121.9** | 121.6 | 121.1 | 119.2 |
| Educational Services | Prince Edward Island | 145.7 | 153.6 | **154.2** | 152.1 | 149.5 | *142.1* |
| Finance, Insurance and Real Estate | Saskatchewan | *141.3* | 150.3 | 152.7 | **152.9** | 152.1 | 148.9 |
| Health Care and Social Assistance | British Columbia | *132.8* | 142.2 | 145.2 | 146.9 | **147.1** | 146.2 |
| Information, Culture and Recreation | Saskatchewan | *129.0* | 135.2 | **136.2** | 135.8 | 135.0 | 132.6 |
| Management, Administative and Other Support | Manitoba | *126.8* | 131.9 | 133.1 | **133.3** | 133.0 | 131.6 |
| Other Services | New Brunswick | *141.3* | 150.8 | 153.3 | **154.1** | 153.8 | 151.9 |
| Professional, Scientifice and Technical Services | Alberta | *126.2* | 132.4 | 133.8 | **134.0** | 133.5 | 131.3 |
| Public Administration | Prince Edward Island | 139.4 | 146.1 | **146.6** | 145.3 | 143.5 | *138.6* |
| Trade | New Brunswick | *133.6* | 138.8 | **139.3** | 138.3 | 137.1 | 133.7 |
| Transportation and Warehousing | Nova Scotia | *128.4* | 134.4 | 135.9 | **136.2** | 135.7 | 133.5 |
| Full Time Employment | Newfoundland | *108.7* | 115.1 | 117.5 | 119.0 | **119.5** | 119.3 |
| Part Time Employment | Nova Scotia | *107.1* | 108.8 | 109.5 | 109.9 | 110.1 | **110.3** |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

5) and the lowest relative gains (see Table 6) among the provinces, i.e., the results here are the best gains and the worse gains for the variables among the provinces. Table 5 and Table 6 demonstrate the range of efficiency gains at provincial levels for employment related type variables.

TABLE 6. Lowest Relative Efficiency Gains Among Provinces of Employment by Class of Worker, Sector and Industry by Alpha Values

Level Estimates

| **Employment** | **Province** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | | |
| Employees | British Columbia | 112.0 | **112.6** | 111.8 | 110.2 | 108.9 | *105.9* |
| Self Employed | Ontario | 117.4 | **119.1** | 118.5 | 117.1 | 115.7 | *112.5* |
| **By Sector** | | | | | | | |
| Public Sector | Ontario | *116.1* | 120.4 | **121.1** | 120.9 | 120.3 | 118.5 |
| Private Sector | Québec | *111.5* | 115.3 | **116.0** | 115.8 | 115.2 | 113.4 |
| **Goods-Producing** | Ontario | 112.0 | **112.6** | 111.5 | 109.6 | 108.1 | *104.9* |
| Agriculture | British Columbia | **105.9** | 101.5 | 99.1 | 96.7 | 95.2 | *92.5* |
| Construction | Alberta | **121.0** | 119.0 | 116.6 | 113.6 | 111.5 | *107.4* |
| Manufacturing | Ontario | **110.4** | 109.3 | 107.4 | 104.9 | 103.0 | *99.5* |
| Natural Resources | British Columbia | **92.3** | 87.5 | 84.7 | 82.0 | 80.2 | *76.9* |
| Utilities | British Columbia | **108.7** | 103.6 | 99.5 | 95.1 | 92.2 | *87.3* |
| **Services-Producing** | Prince Edward Island | 107.1 | **109.3** | 108.8 | 107.3 | 105.9 | *102.7* |
| Accomodation and Food Services | Newfoundland | **120.2** | 113.9 | 109.7 | 105.1 | 102.0 | *96.3* |
| Educational Services | Nova Scotia | **124.2** | 121.4 | 118.3 | 114.5 | 111.8 | *106.7* |
| Finance, Insurance and Real Estate | Prince Edward Island | **126.0** | 126.0 | 121.4 | 114.8 | 109.9 | *101.0* |
| Health Care and Social Assistance | Prince Edward Island | 129.4 | **130.6** | 128.6 | 125.3 | 122.7 | *117.6* |
| Information, Culture and Recreation | New Brunswick | **106.6** | 102.7 | 99.9 | 96.8 | 94.6 | *90.6* |
| Management, Administative and Other Support | Newfoundland | **108.0** | 104.0 | 101.3 | 98.5 | 96.7 | *93.6* |
| Other Services | Prince Edward Island | **107.0** | 104.8 | 102.6 | 100.1 | 98.4 | *95.6* |
| Professional, Scientifice and Technical Services | Newfoundland | **101.5** | 96.8 | 93.9 | 90.9 | 89.0 | *85.4* |
| Public Administration | Newfoundland | **118.4** | 117.9 | 115.8 | 112.8 | 110.6 | *106.1* |
| Trade | Newfoundland | 110.6 | **113.8** | 113.6 | 112.3 | 110.8 | *107.2* |
| Transportation and Warehousing | Newfoundland | **108.7** | 105.7 | 103.0 | 99.8 | 97.7 | *93.6* |
| Full Time Employment | Saskatchewan | *100.4* | 103.2 | 104.1 | 104.7 | 104.9 | **105.0** |
| Part Time Employment | Newfoundland | **98.8** | 98.5 | 98.1 | 97.5 | 97.1 | *96.2* |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

The current $\alpha = 0.67$ produces many of the best gains for the variables (See Table 5)while it stays away from the worse gains which occur more often at $\alpha = 0.80$ (See Table 6). Many of the worse gains that the current $\alpha = 0.67$ produces can be corrected by introducing a smaller $\alpha$ value, $\alpha = 0.20$ for example. But the less efficient estimates tend to be in smaller provinces such as the eastern provinces.

## CHANGE ESTIMATES:

### 4.2.4 Labour force status variables (in LF, employment, unemployment and unemployment rates by major age groups, sex and province and Canada total)

The current $\alpha = 0.67$ produces very efficient estimates of change as compared with other choices of $\alpha$ value. While the best $\alpha$ value for estimates of change is at a higher value of at least $\alpha = 0.80$ for Employment related variables, the current $\alpha = 0.67$ produces efficient estimates close to those for $\alpha = 0.80$ (Most of the differences of gains are within 5%). As for Unemployment related variables, the differences of gains between the current $\alpha = 0.67$ and the best gains are very minimal (within 1%). See Table 7 below at the Canada level. The results of Employment and Unemployment by sex and major age groups are in Appendix.

TABLE 7. Relative Efficiency by Labour Force Status, Canada by Alpha Values

Change Estimates

| **Labour Force Status** | **Sexes** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| Employment | Both Sexes | *111.3* | 128.7 | 137.4 | 145.3 | 149.7 | **155.9** |
| | Males | *115.5* | 127.6 | 133.0 | 137.4 | 139.6 | **142.3** |
| | Females | *121.9* | 138.6 | 146.6 | 153.7 | 157.7 | **163.3** |
| In Labour Force | Both Sexes | *108.2* | 123.4 | 131.0 | 137.7 | 141.5 | **146.8** |
| | Males | *110.6* | 121.3 | 126.0 | 129.9 | 131.9 | **134.4** |
| | Females | *118.1* | 132.3 | 139.0 | 144.8 | 148.1 | **152.5** |
| Unemployment | Both Sexes | *106.5* | 107.8 | 108.1 | **108.2** | 108.2 | 107.9 |
| | Males | *106.5* | 107.5 | **107.7** | 107.6 | 107.5 | 107.1 |
| | Females | *107.5* | 108.5 | 108.7 | **108.7** | 108.6 | 108.3 |
| Unemployment Rate | Both Sexes | *107.0* | 108.6 | 109.0 | **109.1** | 109.0 | 108.6 |
| | Males | *106.7* | 107.8 | **107.9** | 107.8 | 107.7 | 107.2 |
| | Females | *108.9* | 110.1 | **110.4** | 110.4 | 110.2 | 109.6 |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

Similar results can be seen for provincial estimates of change for the Employment and

Unemployment variables (See Table 8). While again the best α value for estimates of change are at a higher α value α = 0.80 for the Employment, the current α = 0.67 produces estimates close to those for α = 0.80 (Most of the differences of gains are within 6%). The best results for Unemployment (and related variables) at the provincial level tend to be for α values α = 0.50 or α = 0.60. (Most of the differences of gains are within 1%).

TABLE 8. Relative Efficiency by Labour Force Status and Province by Alpha Values

Change Estimates

| Labour Force Status | Province | 0.20 | 0.40 | 0.50 | 0.60 | 0.67 | 0.80 |
|---|---|---|---|---|---|---|---|
| Employment | Newfoundland | *104.1* | 122.3 | 131.5 | 139.9 | 144.8 | **151.6** |
| | Prince Edward Island | *107.2* | 123.1 | 130.8 | 137.6 | 141.5 | **146.8** |
| | Nova Scotia | *105.9* | 124.2 | 133.7 | 142.5 | 147.6 | **154.9** |
| | New Brunswick | *114.9* | 133.3 | 142.4 | 150.5 | 155.0 | **161.1** |
| | Québec | *109.6* | 127.6 | 136.6 | 144.8 | 149.5 | **156.0** |
| | Ontario | *111.8* | 130.1 | 139.4 | 148.0 | 153.0 | **159.8** |
| | Manitoba | *105.5* | 120.9 | 128.5 | 135.5 | 139.4 | **144.9** |
| | Saskatchewan | *109.1* | 125.8 | 134.3 | 142.1 | 146.7 | **153.6** |
| | Alberta | *112.6* | 127.2 | 134.2 | 140.4 | 143.9 | **148.7** |
| | British Columbia | *116.2* | 131.6 | 139.1 | 145.6 | 149.3 | **154.4** |
| Unemployment | Newfoundland | *104.9* | 105.9 | 106.1 | **106.2** | 106.1 | 105.8 |
| | Prince Edward Island | *111.0* | 117.6 | 120.4 | 122.6 | 123.8 | **125.4** |
| | Nova Scotia | 108.8 | **109.1** | 108.9 | 108.5 | 108.1 | *107.2* |
| | New Brunswick | **109.1** | 108.4 | 107.9 | 107.3 | 106.9 | *105.9* |
| | Québec | *106.7* | 108.6 | 109.2 | 109.6 | 109.8 | **109.8** |
| | Ontario | *106.2* | 107.2 | **107.4** | 107.3 | 107.2 | 106.8 |
| | Manitoba | *107.2* | 109.1 | 109.7 | 110.0 | **110.1** | 109.6 |
| | Saskatchewan | *102.1* | 104.3 | 105.2 | 106.0 | 106.4 | **107.1** |
| | Alberta | *105.4* | 106.1 | **106.2** | 106.2 | 106.1 | 105.8 |
| | British Columbia | 108.2 | 108.9 | **108.9** | 108.8 | 108.6 | *108.1* |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

### 4.2.5 Employment by Class of Worker, Sector, Industry and Status, Canada

The current α = 0.67 produces very efficient estimates as compared with other choices of α value. While the best choice α value for estimates of change are at a higher α value α = 0.80 for the Employment related variables, the current α = 0.67 produces gains within 10%. These gains at α = 0.67 are very substantial (see Table 9).

TABLE 9. RE of Employment by Class of Worker, Sector and Industry, Canada by Alpha Values

| CHANGE ESTIMATES<br>**Employment** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | |
| Employees | *121.0* | 140.0 | 149.2 | 157.3 | 161.8 | **168.1** |
| Self Employed | *140.2* | 164.0 | 174.8 | 183.8 | 188.6 | **194.4** |
| **By Sector** | | | | | | |
| Public Sector | *136.1* | 163.0 | 176.0 | 187.5 | 193.8 | **202.3** |
| Private Sector | *119.5* | 137.5 | 146.1 | 153.6 | 157.7 | **163.1** |
| **Goods-Producing** | *126.8* | 147.3 | 156.7 | 164.7 | 169.0 | **174.5** |
| Agriculture | *104.4* | 133.8 | 149.9 | 165.1 | 174.0 | **187.1** |
| Construction | *135.4* | 149.3 | 155.0 | 159.5 | 161.7 | **164.2** |
| Manufacturing | *134.3* | 156.2 | 166.3 | 174.9 | 179.5 | **185.3** |
| Natural Resources | *124.4* | 140.2 | 146.8 | 152.0 | 154.6 | **157.3** |
| Utilities | *153.0* | 177.3 | 188.2 | 197.4 | 202.1 | **207.6** |
| **Services-Producing** | *120.8* | 143.0 | 154.0 | 164.0 | 169.7 | **177.5** |
| Accomodation and Food Services | *136.5* | 150.5 | 156.3 | 161.0 | 163.4 | **166.5** |
| Educational Services | *146.8* | 172.2 | 183.9 | 193.9 | 199.3 | **206.4** |
| Finance, Insurance and Real Estate | *147.3* | 174.0 | 186.4 | 197.0 | 202.7 | **210.0** |
| Health Care and Social Assistance | *152.1* | 178.3 | 190.6 | 201.4 | 207.3 | **215.5** |
| Information, Culture and Recreation | *134.5* | 150.9 | 157.9 | 163.6 | 166.6 | **170.3** |
| Management, Administative and Other Support | *132.9* | 144.5 | 149.3 | 153.1 | 155.1 | **157.6** |
| Other Services | *137.6* | 152.3 | 158.4 | 163.3 | 165.7 | **168.6** |
| Professional, Scientifice and Technical Services | *136.2* | 156.4 | 165.6 | 173.3 | 177.5 | **182.8** |
| Public Administration | *136.7* | 162.4 | 174.7 | 185.5 | 191.5 | **199.5** |
| Trade | *146.6* | 167.3 | 176.4 | 183.9 | 187.8 | **192.6** |
| Transportation and Warehousing | *140.0* | 158.8 | 167.0 | 173.7 | 177.1 | **180.9** |
| Full Time Employment | *104.1* | 112.5 | 116.3 | 119.5 | 121.2 | **123.5** |
| Part Time Employment | *102.5* | 103.8 | 104.3 | 104.7 | 104.9 | **105.2** |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

### 4.2.6 Employment by Class of Worker, Sector, Industry and Status, Provinces

Since there are 10 different sets of results for the 10 provinces' Employment by Class of Worker, by Sector, by Industry variables, we present here only the highest relative efficiency gains (See Table 10) and the lowest relative gains (See Table 11) among the provinces, i.e., the results here are the best gains and the worse gains for the variables among the provinces.

The current $\alpha = 0.67$ produces very efficient estimates as compared with other choices of $\alpha$ value. While the best choice $\alpha$ value for estimates of change are at a higher $\alpha$ value $\alpha = 0.80$ for the Employment related variables, the current $\alpha = 0.67$ produces gains are within 10% range from the

$\alpha = 0.80$ given that these gains at $\alpha = 0.67$ are very substantial.

TABLE 10. Highest Relative Efficiency Gains Among Provinces of Employment by Class of Worker, Sector and Industry by Alpha Values

| Change Estimates **Employment** | **Province** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | | |
| Employees | Saskatchewan | *122.5* | 144.4 | 155.3 | 165.2 | 170.9 | **179.2** |
| Self Employed | Saskatchewan | *110.6* | 144.5 | 164.4 | 184.7 | 197.6 | **218.9** |
| **By Sector** | | | | | | | |
| Public Sector | Saskatchewan | *147.0* | 179.1 | 195.5 | 210.4 | 218.8 | **230.1** |
| Private Sector | Saskatchewan | *118.7* | 140.1 | 150.8 | 160.7 | 166.4 | **175.0** |
| **Goods-Producing** | Alberta | *128.5* | 153.2 | 165.2 | 175.8 | 181.7 | **190.0** |
| Agriculture | Nova Scotia | *155.1* | 187.1 | 202.7 | 215.9 | 222.8 | **230.3** |
| Construction | Manitoba | *149.7* | 163.7 | 169.1 | 173.0 | 174.6 | **175.5** |
| Manufacturing | Saskatchewan | *155.8* | 184.0 | 197.2 | 208.6 | 214.8 | **222.6** |
| Natural Resources | Saskatchewan | *127.4* | 160.7 | 179.9 | 200.1 | 213.4 | **238.0** |
| Utilities | Prince Edward Island | *194.2* | 297.3 | 362.3 | 421.8 | 452.0 | **484.1** |
| **Services-Producing** | Saskatchewan | *116.0* | 145.2 | 161.5 | 177.5 | 187.2 | **202.2** |
| Accomodation and Food Services | Saskatchewan | *143.5* | 161.5 | 169.6 | 176.6 | 180.4 | **186.2** |
| Educational Services | Prince Edward Island | *184.5* | 223.4 | 243.4 | 262.0 | 272.7 | **287.6** |
| Finance, Insurance and Real Estate | Saskatchewan | *176.7* | 215.0 | 235.0 | 253.9 | 265.0 | **281.3** |
| Health Care and Social Assistance | Prince Edward Island | *166.1* | 196.2 | 211.5 | 225.9 | 234.6 | **248.5** |
| Information, Culture and Recreation | Saskatchewan | *145.9* | 172.3 | 184.8 | 195.6 | 201.6 | **209.9** |
| Management, Administative and Other Support | Prince Edward Island | *149.1* | 168.5 | 176.4 | 182.2 | 184.8 | **186.6** |
| Other Services | Québec | *138.8* | 159.8 | 169.6 | 178.0 | 182.6 | **188.5** |
| Professional, Scientifice and Technical Services | Prince Edward Island | *153.8* | 173.1 | 182.8 | 192.5 | 198.9 | **211.2** |
| Public Administration | Manitoba | *160.6* | 200.0 | 221.1 | 241.8 | 254.6 | **274.9** |
| Trade | Prince Edward Island | *175.3* | 206.3 | 221.2 | 234.5 | 241.9 | **251.9** |
| Transportation and Warehousing | Saskatchewan | *158.9* | 180.5 | 190.0 | 197.7 | 201.7 | **206.1** |
| **Employment** | New Brunswick | *114.9* | 133.3 | 142.4 | 150.5 | 155.0 | **161.1** |
| Full Time Employment | Newfoundland | *103.2* | 114.5 | 119.7 | 124.2 | 126.6 | **129.9** |
| Part Time Employment | New Brunswick | *103.6* | 105.1 | 105.6 | 106.0 | 106.3 | **106.5** |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

TABLE 11. Lowest Relative Efficiency Gains Among Provinces of Employment by Class of Worker, Sector and Industry by Alpha Values

| Change Estimates Employment | Province | 0.20 | 0.40 | 0.50 | 0.60 | 0.67 | 0.80 |
|---|---|---|---|---|---|---|---|
| **By Class of Worker** | | | | | | | |
| Employees | Newfoundland | *111.5* | 124.0 | 129.6 | 134.2 | 136.7 | **140.1** |
| Self Employed | Saskatchewan | *110.6* | 144.5 | 164.4 | 184.7 | 197.6 | **218.9** |
| **By Sector** | | | | | | | |
| Public Sector | Newfoundland | *118.5* | 144.6 | 158.3 | 171.4 | 179.2 | **190.9** |
| Private Sector | Newfoundland | *114.7* | 128.5 | 134.6 | 139.8 | 142.5 | **146.0** |
| **Goods-Producing** | Saskatchewan | *101.5* | 129.6 | 145.4 | 161.0 | 170.6 | **185.8** |
| Agriculture | Saskatchewan | *85.3* | 114.7 | 133.1 | 153.3 | 166.9 | **191.1** |
| Construction | Newfoundland | *126.1* | 136.8 | 141.1 | 144.5 | 146.3 | **148.4** |
| Manufacturing | New Brunswick | *123.5* | 141.0 | 148.7 | 154.9 | 158.1 | **161.9** |
| Natural Resources | British Columbia | *109.7* | 114.4 | 115.9 | 116.8 | **117.1** | 116.8 |
| Utilities | New Brunswick | *142.3* | 163.8 | 175.6 | 187.3 | 194.3 | **204.4** |
| **Services-Producing** | Newfoundland | *97.6* | 122.5 | 136.5 | 150.4 | 159.0 | **172.5** |
| Accomodation and Food Services | Alberta | *130.5* | 140.7 | 144.9 | 148.2 | 149.9 | **152.2** |
| Educational Services | Manitoba | *139.3* | 160.3 | 170.0 | 178.5 | 183.1 | **189.2** |
| Finance, Insurance and Real Estate | Ontario | *141.5* | 170.8 | 185.1 | 197.9 | 205.0 | **214.7** |
| Health Care and Social Assistance | Alberta | *143.9* | 165.5 | 175.1 | 183.4 | 187.9 | **194.0** |
| Information, Culture and Recreation | Ontario | *132.6* | 149.0 | 156.2 | 162.3 | 165.7 | **170.2** |
| Management, Administative and Other Support | Newfoundland | *125.8* | 134.3 | 137.6 | 140.2 | 141.5 | **143.3** |
| Other Services | Saskatchewan | *133.5* | 150.6 | 158.0 | 164.1 | 167.3 | **171.2** |
| Professional, Scientifice and Technical Services | Québec | *134.8* | 153.9 | 162.3 | 169.1 | 172.6 | **176.6** |
| Public Administration | Ontario | *131.6* | 164.2 | 181.5 | 197.8 | 207.5 | **221.8** |
| Trade | Newfoundland | *133.5* | 154.5 | 164.6 | 173.5 | 178.4 | **185.3** |
| Transportation and Warehousing | Newfoundland | *124.2* | 134.8 | 139.0 | 142.3 | 143.9 | **145.6** |
| **Employment** | Newfoundland | *104.1* | 122.3 | 131.5 | 139.9 | 144.8 | **151.6** |
| Full Time Employment | Nova Scotia | *101.4* | 111.9 | 116.8 | 121.0 | 123.3 | **126.3** |
| Part Time Employment | Prince Edward Island | *94.0* | 95.5 | 96.1 | 96.6 | 96.9 | **97.2** |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

In summary, for variables that are added as composite control totals, such as employment by industry, there are substantial gains in efficiency. For most industries, gains of 10 to 20 percent are typical for estimates of level, but they can be as high as 40-50 percent at province level. A 40

percent efficiency gain corresponds, for example, to reducing a 15 percent coefficient of variation to 12.7 percent and a 10 percent coefficient of variation to 8.5 percent. For province-level Employment and Unemployment estimates, the efficiency gains are more modest, typically in the 20% range for Employment and 5% to 10% percent range for Unemployment estimates. For estimates of month-to-month change, the efficiency gains for controlled variables are much bigger, usually more than double the gains for estimates of level.

For variables that are not controlled, there is little or no effect of composite estimation on efficiency unless the variable is highly correlated with a controlled variable. For example, at the province level, full-time employment shows a gain in efficiency because it is correlated with total employed, which is controlled. On the other hand, employment or unemployment by subprovincial region such as by the LFS urban centres (results in a separate small area estimation study) shows neither gains nor losses.

## 4. CONCLUDING REMARKS

In our study, we evaluate and present a broad range of $\alpha$ values, their impacts on the final weights, the break-in period required for the benefits of 'compositing' to be fully realized, and the relative efficiency for both level and change estimates on all published release tables.

The presence of extreme weights in terms of magnitude of negative weights and number of negative weights are directly related to the choices of $\alpha$ value. They are however manageable and are very rare at the Canada level. The impact on provincial estimates is almost non-existent. The break-in period required for the benefits of 'compositing' to be fully realized is related to the characteristics under study. We found a minimum of 24 to 30 months (30 months used in our study) would be a reasonable choice given the fact that a single starting month is used for all characteristics. This is both to ensure that we fully realize all the gains and for operational simplicity.

The results from 6 different choices of $\alpha$ value indicate the current value of $\alpha = 0.67$ is a very good compromise choice for the wide range of characteristics in the provinces and Canada for both level and change estimates. The gains for the level estimates are significant with the current $\alpha$ value and it is the best choice for employment variables for almost all provinces. The gains for the change estimates are quite substantial and very close to the 'optimal' $\alpha$ value at $\alpha = 0.80$ under study.

The current $\alpha = 0.67$ is a good compromise between level and changes estimates. Though more gains could be realised by introducing a different $\alpha$ value especially to improve the efficiency of unemployment estimates in few smaller provinces or to have the 'optimal' gains for some employment by industry characteristics, this would further complicate the weighting procedure. We will need to investigate the properties of the unique final weight when two different $\alpha$ values are used simultaneously before implementation.

The estimation system has a few more extreme weights (e.g., more negative weights) with the introduction of the additional composite estimates as control totals. This is expected because the final weights have to satisfy many more controls simultaneously. Efforts are underway to examine all controls especially the controls at the LFS urban centres level. We are also going to examine the relative efficiency under a different LFS design, i.e., changing from the current six rotation groups to a four rotation groups design.

## ACKNOWLEDGEMENTS

We would like to express our thanks to Dr. M. P. Singh for the guidance, to Jack Gambino and Eric Rancourt for many useful discussions during the development of this project, and to René Boyer for use and help of the very complex variance computer programs.

Appendix:

A1: Relative Efficiency by Labour Force Status by Sex/Age Group Level Estimates

A2: Relative Efficiency by Labour Force Status by Sex/Age Group Change Estimates

A3: Controls Specification for Composite Estimation System

TABLE A1. Relative Efficiency by Labour Force Status, Canada by Alpha Values

Level Estimates

| **Labour Force Status** | **Sexes** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| Employment | Males | *111.5* | 116.0 | 117.3 | **117.7** | 117.5 | 116.1 |
| | 15-24 | 114.3 | 115.8 | **115.8** | 115.4 | 115.0 | *113.9* |
| | 25+ | *109.4* | 114.8 | 116.5 | **117.3** | 117.2 | 115.7 |
| | Females | *114.1* | 113.6 | 119.8 | 127.1 | **129.6** | 114.7 |
| | 15-24 | 107.0 | *106.8* | 114.3 | **115.3** | 115.1 | 112.7 |
| | 25+ | 116.6 | 116.2 | 121.2 | 130.7 | **134.3** | *115.0* |
| Unemployment | Males | **105.9** | 105.7 | 105.4 | 104.8 | 104.4 | *103.4* |
| | 15-24 | **101.7** | 101.5 | 101.3 | 101.1 | 100.9 | *100.7* |
| | 25+ | **108.0** | 108.0 | 107.6 | 107.0 | 106.5 | *105.3* |
| | Females | **104.7** | 104.3 | 103.8 | 103.1 | 102.6 | *101.5* |
| | 15-24 | 103.6 | **103.9** | 103.8 | 103.7 | 103.6 | *103.5* |
| | 25+ | **105.0** | 104.2 | 103.5 | 102.6 | 101.9 | *100.5* |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

TABLE A2. Relative Efficiency by Labour Force Status, Canada by Alpha Values

Change Estimates

| **Labour Force Status** | **Sexes** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| Employment | Males | *115.5* | 127.6 | 133.0 | 137.4 | 139.6 | **142.3** |
| | 15-24 | *122.3* | 128.6 | 131.0 | 132.8 | 133.7 | **134.9** |
| | 25+ | *112.9* | 127.0 | 133.5 | 139.1 | 142.0 | **145.5** |
| | Females | *121.9* | 138.6 | 146.6 | 153.7 | 157.7 | **163.3** |
| | 15-24 | *124.1* | 130.7 | 133.2 | 135.2 | 136.2 | **137.7** |
| | 25+ | *122.1* | 142.2 | 152.4 | 161.7 | 167.0 | **174.5** |
| Unemployment | Males | *106.5* | 107.5 | **107.7** | 107.6 | 107.5 | 107.1 |
| | 15-24 | *105.5* | 106.5 | 106.8 | 107.0 | 107.1 | **107.4** |
| | 25+ | *107.9* | 108.8 | **108.9** | 108.7 | 108.4 | 107.7 |
| | Females | *107.5* | 108.5 | 108.7 | **108.7** | 108.6 | 108.3 |
| | 15-24 | *103.3* | 103.7 | 103.8 | 103.9 | 103.9 | **104.2** |
| | 25+ | *109.7* | 111.2 | 111.5 | **111.6** | 111.6 | 111.0 |

Figures in bold face indicate the highest gains and italics indicate the lowest among the alpha values.

# A3: Controls Specification for Composite Estimation System

## 1. DEMOGRAPHIC POPULATION CONTROLS

### 1.1 24 age/sex group controls for each province

For each province, 24 age/sex groups are controlled. They are:

0 - 14
15 - 16
17 - 19
20 - 24
25 - 29
30 - 34
35 - 44 By Male and Female
45 - 54
55 - 59
60 - 64
65 - 69
70+

### 1.2 5 rotation group controls for each province

For each province, 5 rotation groups are controlled, i.e., each rotation group is controlled to equal 1/6 of the population 15+. Another rotation group control is met without specifying.

### 1.3 2 household sizes and 2 economic family sizes controls for each province

For each province, 2 household sizes, i.e., household size with Size 1 and Size 2 and 2 economic family sizes, i.e., economic family size with Size 1 and Size 2 are controlled. Other size controls are met without specifying.

### 1.4. Economic region controls by province

For each province, different economic regions are controlled depending on the economic region specified by HRDC. They are:

**NFLD (4)**: 010, 020, 030 , 040
**PEI (1)**: 110
**N.S. (5)**: 210, 220, 230, 240, 250
**N.B. (5)**: 310, 320, 330, 340, 350
**QUE (16)**: 410, 415, 420, 425, 430, 435, 440, 445, 450, 455, 460, 465, 470,

| | |
|---|---|
| | 475, 480, 490 |
| **ONT. (11)**: | 510, 515, 520, 530, 540, 550, 560, 570, 580, 590, 595 |
| **MAN. (8)**: | 610, 620, 630, 640, 650, 660, 670, 680 |
| **SASK (6)**: | 710, 720, 730, 740, 750 , 760 |
| **ALBT (8):** | 810, 820, 830, 840, 850, 860, 870, 880 |
| **B.C (8).** | 910, 920, 930, 940, 950, 960, 970, 980. |

### 1.5 City Controls (LFS urban centres)

For each province, different city i.e., CMA/CA or urban centres are controlled including all the LFS urban centres currently in the LFS design. They are:

| | |
|---|---|
| **NFLD (2)**: | ST. JOHN'S, CORNER BROOK - DEER LAKE |
| **PEI (2)**: | CHARLOTTETOWN, SUMMERSIDE |
| **N.S. (4)**: | HALIFAX, SYDNEY - SYDNEY MINES,<br>NEW GLASGOW, TRURO |
| **N.B. (6)**: | SAINT JOHN, BATHURST, CHATHAM – NEWCASTLE,<br>MONCTON, FREDERICTON, EDMUNSTON |
| **QUE (10)**: | CHICOUTIMI – JONQUIERE, QUEBEC, MONTREAL,<br>HULL, TROIS-RIVIERES, SEPT-ILES, BAIE-COMEAU,<br>RIMOUSKI, SHERBROOKE,<br>ROUYN-NORANDA/VAL-D'OR -MALARTIC |
| **ONT. (18)**: | OTTAWA, SUDBURY, TORONTO, HAMILTON,<br>ST. CATHARINES – NIAGARA, LONDON, WINDSOR,<br>KITCHENER, THUNDER BAY, OSHAWA, CORNWALL,<br>KINGSTON, PETERBOROUGH, GUELPH,<br>BRANTFORD, SARNIA-CLEARWATER,<br>SAULT STE. MARIE, NORTH BAY |
| **MAN. (2)**: | WINNIPEG, BRANDON |
| **SASK (4)**: | REGINA, SASKATOON, MOOSE JAW,<br>PRINCE ALBERT |
| **ALBT (7)**: | CALGARY, EDMONTON, LETHBRIDGE,<br>MEDICINE HAT, RED DEER, GRANDE PRAIRIE,<br>FORT MCMURRAY |
| **B.C (9).** | VANCOUVER, VICTORIA, KELOWNA, KAMLOOPS,<br>MATSQUI, CHILLIWACK – HOPE, NANAIMO,<br>PRINCE GEORGE, DAWSON CREEK |

# 2. COMPOSITE ESTIMATE CONTROLS

## 2.1 PROVINCE LEVEL LABOUR FORCE CHARACTERISTIC

PROVINCE LEVEL EMPLOYED.
PROVINCE LEVEL UNEMPLOYED.
*PROVINCE LEVEL NOT IN THE LABOUR FORCE.*

## 2.2 LABOUR FORCE CHARACTERISTIC BY AGE/SEX GROUPS

EMPLOYED, MALES, 15 - 24.
UNEMPLOYED MALES 15 - 24.
NOT IN LABOUR FORCE, MALES, 15 - 24.
EMPLOYED, MALES, 25 +.
UNEMPLOYED MALES 25 +.
NOT IN LABOUR FORCE, MALES, 25 +.
EMPLOYED, FEMALES, 15 - 24.
UNEMPLOYED FEMALES 15 - 24.
NOT IN LABOUR FORCE, FEMALES, 15 - 24.
*EMPLOYED, FEMALES, 25 +.*
*UNEMPLOYED FEMALES 25 +.*
*NOT IN LABOUR FORCE, FEMALES, 25 +.*

## 2.3 EMPLOYMENT BY INDUSTRY

AGRICULTURE
CONSTRUCTION
INFORMATION, CULTURE AND RECREATION
UTILITIES
MANUFACTURING
NATURAL RESOURCES
TRANSPORTATIONS AND WAREHOUSING
FINANCE, INSURANCE AND REAL ESTATE
PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES
MANAGEMENT, ADMINISTATIVE AND OTHER SUPPORT
EDUCATIONAL SERVICES
HEALTH CARE AND SOCIAL ASSISTANCE
ACCOMMODATION AND FOOD SERVICES
PUBLIC ADMINISTRATION
TRADE
*OTHER SERVICES.*

## 2.4 EMPLOYMENT BY CLASS OF WORKER

EMPLOYED, PUBLIC EMPLOYEE
EMPLOYED, PRIVATE EMPLOYEE
*EMPLOYED, PRIVATE SELF EMPLOYED.*

**NOTE:** ***ITALICS*** **INDICATE THE CONTROL IS MET, i.e., NEED NOT BE SPECIFIED.**

## 3. Total Number of Control Totals in the Estimation System

| | Demography | Composites | ER | City | Total |
|---|---|---|---|---|---|
| **NEWFOUNDLAND**: | 33 | 28 | 4 | 2 | 67 |
| **PEI.**: | 33 | 28 | 1 | 2 | 64 |
| **NOVA SCOTIA**: | 33 | 28 | 5 | 4 | 70 |
| **N.B.**: | 33 | 28 | 5 | 6 | 72 |
| **QUEBEC**: | 33 | 28 | 16 | 10 | 87 |
| **ONTARIO**: | 33 | 28 | 11 | 18 | 90 |
| **MANITOBA**: | 33 | 28 | 8 | 2 | 71 |
| **SASKATCHEWAN**: | 33 | 28 | 6 | 4 | 71 |
| **ALBERTA:** | 33 | 28 | 8 | 7 | 76 |
| **B.C.:** | 33 | 28 | 8 | 9 | 78 |

## REFERENCES


FULLER, W.A., and RAO, J.N.K. (2001). A Regression Composite Estimator with Application to the Canadian Labour Force Survey. *Survey Methodology*, Vol. 27, pp. 45-51.

GAMBINO, J.G., SINGH, M.P., DUFOUR, J., KENNEDY, B., and LINDEYER, J. (1998). *Methodology of the Canadian Labour Force Survey*. Statistics Canada, Catalogue number 71-526.

GAMBINO, J.G., KENNEDY, B. and SINGH, M.P. (2001). Regression Composite Estimation for the Canadian Labour Force Survey: Evaluation and Implementation. *Survey Methodology*, Vol. 27, pp. 65-74.

KUMAR, S., and LEE, H. (1983). Evaluation of Composite Estimation for the Canadian Labour Force Survey. *Survey Methodology*, 9, 178-201.

SINGH, A.C., KENNEDY, B., WU, S. and BRISEBOIS F. (1997). Composite Estimation for the Canadian Labour Force Survey. Proceedings of the Survey Research Methods Section, American Statistical Association, 300-305.

SINGH, A.C., KENNEDY, B. and WU, S. (2001). Regression Composite Estimation for the Canadian Labour Force Survey with a Rotating Panel Design. *Survey Methodology*, Vol. 33-44,.

## 1. INTRODUCTION

The Canadian Labour Force Survey (LFS) is a monthly survey of approximately 54,000 households selected using a stratified multistage design. Households stay in the sample for six consecutive months, thus five-sixths of the sample is common between two consecutive months. Each month, the members of a selected household are asked questions about their labour force status, earnings, and so on. In the LFS estimation system used prior to 2000, initial design weights were modified using regression to produce final weights that respect age-sex and geographical (subprovincial region) *population control totals*. Each record then had a *unique final weight* that is used for all tabulations.

Since January 2000, the LFS has successfully implemented a new estimator known as the regression composite estimator - see Gambino, Kennedy and Singh (2001) for a detailed discussion from which most of the introduction of this paper has heavily borrowed. The implementation of the new composite estimator is judged not only on its statistical efficiency but also its stability over time and its cost effectiveness, while achieving the following objectives: (i) minimizing changes to the old estimation system, (ii) producing a unique weight for each sample unit (iii) respecting age-sex and geography control totals and (iv) producing consistent estimates (in the sense that, *e.g.*, Employed + Unemployed = Labour Force and Labour Force + Not In Labour Force = Population 15+).

The estimation system prior to composite estimation used data from the current month only (henceforth referred to as GREG). No attempt was made to exploit the fact that the common sample can be used to improve estimates. However, characteristics such as employment (especially employment by industry) are highly correlated over time and unemployment is moderately correlated over time, thus there is potential for efficiency gains. Because of these gains, surveys similar to the LFS, such as the United States Current Population Survey (CPS), have used composite estimation to improve their estimates for many years.

Traditionally, the key estimates produced by the LFS were monthly unemployment rates. However, with the increasing emphasis on estimates of employment level and on estimates of change in recent years, the need to find ways to make use of the common sample also increased since these estimates would benefit significantly. In the mid-1990s, therefore, interest in composite estimation was revived at Statistics Canada, and a regression-based method that fit in well with the existing LFS estimation system was developed. This method is first described in Singh, Kennedy, Wu and Brisebois (1997) with a more up to date version included in Singh *et al.* (2001). The new methodology allows for a

choice of methods, depending on one's objectives. If the primary interest is in estimates of level, then one can use level-driven predictors in the procedure. If change is most important, then change-driven predictors can be used. One can go one step further and include both types of predictor in the procedure.

The method used since January 2000 addressed the problems with traditional composite estimators and showed substantial gains in efficiency. Also both estimates of level and of change were given importance in the choice of predictors. A method suggested by Fuller, that combines the change-driven and level-driven approaches without the constraints associated with including both sets of predictors in the regression was adopted (see Fuller and Rao, 2001). The solution is remarkably straightforward: take a linear combination of the level and change predictors: $X = (1-\alpha)X_L + \alpha X_C$, and use it as the predictor. The level- and change-driven predictors are now special cases, corresponding to $\alpha = 0$ and $\alpha = 1$ respectively. Furthermore, one can choose $\alpha$ to reflect the relative importance one wishes to give to level versus change, i.e., the higher $\alpha$ value would give more importance to change versus level estimates. A compromise choice of $\alpha = 0.67$ is implemented in the current LFS estimation system.

The introduction of the composite estimates also added more control totals to the weighting system. As a result, more extreme final weights could be produced. Moreover, the choice of $\alpha$ value could be related to distortion of the final sample weights.

This paper describes an extensive evaluation of the composite estimator using actual LFS data for a large number of characteristics over a long period of time from July 2000 to June 2001 with February 1998 as the first starting month of composite (i.e., February 1998 to June 2000 is the break-in period). The objectives of the study and methods used to evaluate a broad range of $\alpha$ values ($\alpha$ = 0.20, 0.40, 0.50, 0.60, 0.67 and 0.80) are described in Section 2. The results of the study on the impacts of final weights, the examination of break-in period and the relative efficiency for different $\alpha$ values for both the level and change estimates are summarised in Section 3. The concluding remarks are in Section 4.

## 2. ALPHA VALUES AND STUDY OBJECTIVES

**Choices of α value**: In this study, a wide range of α values is used to evaluate the relative efficiency and the impacts on the final weights. The choices of α value under study are α = 0.20, 0.40, 0.50, 0.60, and 0.80 in addition to the current α value = 0.67. Two additional α values, α = 0.70 and α = 0.75 were also computed to examine the sensitivity of the choice of α value but they are not reported here since most of the results fall in between those of α = 0.67 and α = 0.80. The relative efficiency that evaluates the performance of the variance of the composite estimator compared to the generalised regression estimator (GREG) used prior to the introduction of the composite estimator is defined as

$$RE = Var(GREG)*100/Var(composite).$$

This relative efficiency is computed for each of the α values and the characteristics. A value of RE greater than 100 would indicate composite is a more efficient estimator than the GREG estimator is whereas a value less than 100 would indicate less efficient compared to the GREG estimator.

**Extreme weights**: With the introduction of the composite estimator, 28 more independent variables (see Appendix for the list) for each province have been added in the regression as control totals that may further distort the final weights in the estimation system. The distortion usually results in more extreme weights such as more negative weights or more large weights produced. The distortion could be related to the α values.

**Break-in period**: The relative efficiency gains are related to the number of months of 'compositing' in order for the composite estimator to fully realize its gains. The number of months of 'compositing' required highly depends on the characteristic and its variability and correlation over time. The relative efficiency reported should be after a period when the efficiency gains of the estimates are stabilised, i.e., after the break-in period.

**Study objectives**: The objectives of this study are to investigate:

1. Whether the current α = 0.67 produces 'optimal' (or close to optimal) estimates of both level and change, i.e., whether it is a good compromise choice;
2. Whether a different α value should be used for different characteristics or province;
3. The break-in period, i.e., how many months it takes for the benefit of "compositing" to be fully realized?
4. Impacts of different α values on the final weights and their distribution vs. the GREG

estimator.

Since the value $\alpha = 0.67$ is used for all types of estimates in all provinces in the current estimation system, the characteristics in this study include all the estimates published in the LFS monthly press releases, namely, the variables in Labour Force, Employment, Unemployment and Unemployment rate by major age groups 15-24 years, 25 years and over by sex in all provinces and the Canada total. The employment variables by class of worker (employee and self-employed), by type of industry, by sector (public and private) and by employment status (full-time and part-time) are also included in the study.

In this study, 12 months of LFS data from July, 2000 to June, 2001 are used to compute and compare the relative efficiencies, with the first month composite estimates starting from February, 1998. We also compared the results from the first month composite estimates starting from March, 1995 (the LFS production version) and found no major differences with the results from the first month composite estimates starting from February, 1998.

## 3. RESULTS

We present a detailed summary of results for the 6 different choices of $\alpha$ value in the regression composite estimator. Two additional $\alpha$ values $\alpha = 0.70$ and $\alpha = 0.75$ are also computed to examine the sensitivity of the choice of $\alpha$ values but they are not reported here since most of the results fall in between the $\alpha = 0.67$ and $\alpha = 0.80$ ones. Only some numerical results are presented in the section below.

**3.1 Impacts on final weights**. As discussed in Gambino, Kennedy and Singh (2001), unlike the traditional A-K composite estimator, where weighting to satisfy population control totals and composite estimation are separate steps, weighting for the regression composite estimator is done in one step, *i.e.*, simultaneously with weighting to satisfy the age-sex and geographical controls. This procedure not only preserves the consistency but also retains the benefits of the controls applied to the usual regression estimator, i.e., the age-sex and geographic controls in our case.

These benefits also could have their drawbacks. There could be more extreme final weights produced by the new estimation system in order to satisfy the increased number of control totals. See Appendix for a complete list of demographic control totals and composite controls in the new estimation system. The composite controls have been added to the old system since January 2000 (with rebasing estimates back to January 1996). Moreover, the presence of extreme final weights

could be directly related to the choice of α values.

Table 1 below presents the examination of the final weights by the GREG estimator and the 6 different α values over the 12-month period in Canada. There are a few more extreme weights with the composite estimator. The presence of the extreme weights (by the measures of minimum value, maximum value and minimum and maximum number of negative weights per month) is directly related to the α values. It seems the higher the α value, the more extreme negative weights it produces and the more negative weights per month there are. Therefore, the average number of negative weights per month tends to increase with the α value.1

TABLE 1. Final Weights Distribution: GREG vs. by Alpha Values July, 2000 to June, 2001

| **Final Weights** | **GREG** | **0.20** | **0.40** | **0.50** | **0.60** | ***0.67*** | **0.80** |
|---|---|---|---|---|---|---|---|
| Minimum Weight | -132 | -130 | -133 | -135 | -138 | -200 | -302 |
| Maximum Weight | 2008 | 2068 | 2017 | 1987 | 1954 | 1981 | 2054 |
| Min. No. Neg. Weight/Month | 0 | 0 | 2 | 2 | 4 | 4 | 8 |
| Max. No. Neg. Weight/Month | 4 | 12 | 12 | 13 | 16 | 20 | 25 |
| Ave. No. Neg. Weight/Month | 1.3 | 4.2 | 5.1 | 6.1 | 8.2 | 8.8 | 13.3 |
| 1st Percentile | 31 | 30 | 30 | 30 | 30 | 30 | 30 |
| Median Weight | 165.0 | 164.5 | 164.5 | 164.5 | 164.5 | 164.5 | 164.0 |
| Average Weight | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 | 232.7 |
| 99th Percentile | 913 | 914 | 915 | 917 | 920 | 922 | 923 |

1 These final weights are obtained directly from the variance estimation system, which differs from the production system where the negative weights are replaced by the initial weights and the weighting step is repeated. If there are still negative weights after this step, the negative weights are then replaced by the value 1.

The distribution analysis is also performed over the 12-month period to examine the first percentile, median, average and the 99$^{th}$ percentile of the final weights. The measures do not differ between the GREG and composite estimator nor vary greatly by the $\alpha$ values, as expected.

The negative final weights tend to concentrate in the province of Alberta which accounts for almost 50% of all negative weights. Efforts are under way to examine further this phenomenon.

**3.2 Break-in period.** It is recognized that it takes several months of 'compositing' for the regression composite estimator to fully realize the efficiency gains. The number of months of compositing required highly depends on the variability of the characteristic and correlation over time. In this study, we examine this break-in period for the variables Employment, Unemployment and Employment by Industry in 6 key industries, i.e., the largest 3 and smallest 3 employment industries in Canada. The largest 3 employment industries in order are Employment in Trade, Health Services and Manufacturing. The smallest 3 are Employment in Agriculture, Natural Resources and Utilities.

The examinations are performed by plotting the GREG variance estimates and variance estimates of the composite estimator (with $\alpha = 0.67$) from February, 1998 (when the first month of composite starts) to June, 2001. The reduction of the composite variance of employment in Canada starts to stabilize after 6 months of compositing (See Fig. 1). The 3 major industries show almost immediate gains and start to show stability after about 8 months of compositing. (See Fig. 2, Fig. 3 and Fig. 4). However, it would take about 18 months of compositing for Employment in Agriculture and about 25 months for Employment in Natural Resources to fully realize their gains, mainly due to their variability and correlation over time. Not surprisingly, the GREG variance estimates of the smallest 2 industries i.e., Employment in Natural Resources (See Fig. 5) and in Utilities (See Fig. 6) are very sporadic whereas the composite estimates are much more stable over time. It further demonstrates the stability of the composite estimates vs. the GREG estimates as discussed in Gambino, Kennedy and Singh (2001).

We decided to use after the 30 months of compositing to compute the RE from the examination. 30 months of compositing is a more reasonable choice for the wide range of characteristics and province estimates under study.